EXAMINATION OF AN ALEUTIAN MUMMY

MICHAEL R. ZIMMERMAN,* GENTRY W. YEATMAN,† and HELMUTH SPRINZ

Division of Experimental Pathology
Walter Reed Army Institute of Research

WESLEY P. TITTERINGTON

Fellow in Oral Pathology
Armed Forces Institute of Pathology

Washington, D.C.

A NUMBER of studies of mummies, mostly Egyptian, have been recorded.[1-14] Techniques have included radiology,[2, 5] gross dissection, light microscopy,[3, 6-10] and electron microscopy.[11-13] Modern histopathologic examinations are based on the technique which Marc Armand Ruffer developed in 1909 and which consists of rehydrating mummified tissue with a mixture of alcohol, water, and sodium carbonate.[6] The solution is gradually replaced by alcohol; this results in simultaneous rehydration and fixation. The tissues can then be processed in the same fashion as fresh tissue. Ruffer's method has been little improved since it was first described.

A distinction must be drawn between natural and deliberate mummification. In predynastic Egypt bodies buried in the hot desert sand were mummified by spontaneous desiccation.[6] In dynastic times tombs were built and it became necessary to embalm the deceased. The viscera were preserved either separately, outside the body in canopic jars, or were returned to the body wrapped in linen.[14] Several well-preserved human bodies, believed to be sacrificial victims, have been recovered from peat bogs in Denmark and in northern Germany.[15] These cadavers, dated as 2,000 years old by stratigraphy and pollen analysis, were preserved by a natural process of mummification. The cold, airless environment and the presence of humic and tannic acids in the peat inhibited bacterial growth and tanned the skin.[16]

A pair of naturally preserved Peruvian cadavers mummified by

*Now at the Lankenau Hospital, Philadelphia, Pa., and the Department of Anthropology, University of Pennsylvania, Philadelphia.
†Now at the University of Mississippi School of Medicine, Jackson, Miss.

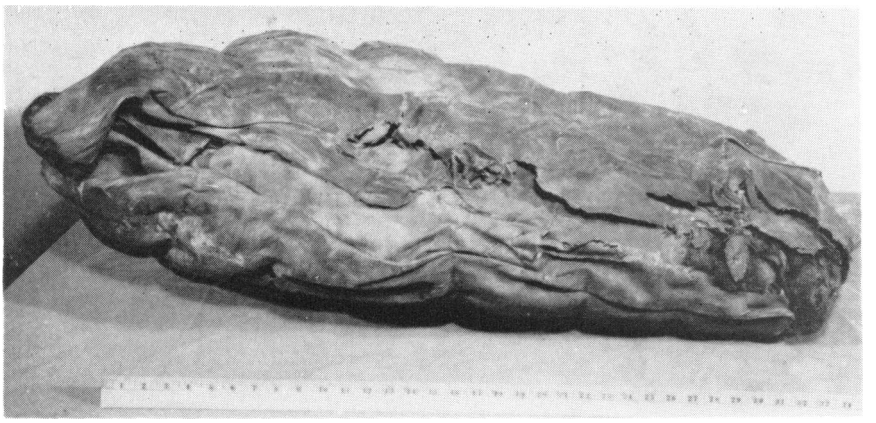


Fig. 1. Mummy bundle, before unwrapping.

desiccation in a cold environment have also been examined.[17] We were given the unusual opportunity of examining a naturally preserved Alaskan mummy by the use of a number of modern pathologic techniques. We were interested especially in ascertaining, if possible, the cause of death, and in determining the effects of the method of preservation on the condition of the tissues.

The mummy examined in this study was acquired from Dr. T. Dale Stewart, senior physical anthropologist of the Museum of Natural History, Smithsonian Institution, Washington, D. C. It was collected in 1938 from a volcanically heated cave on Kagamill Island, in the central part of the Aleutian chain, by Dr. Ales Hrdlicka of the Division of Physical Anthropology, U. S. National Museum.[18] The individual was an Aleut, probably of the immediate pre-Russian era (prior to 1740). There are insufficient archeologic data for more precise dating and the material is too recent to be dated by radiocarbon.[19]

Examination of the Mummy

The mummy bundle was coffin-shaped; it measured 112 cm. in length, 53 cm. in maximum width, and 35 cm. in maximum height (Figure 1). It was wrapped in furs, the outermost layer having the flesh side out. The bundle had been secured externally by circumferential ties. Only the impression of these were found during the examination.

Radiologic examination was performed before and after the un-

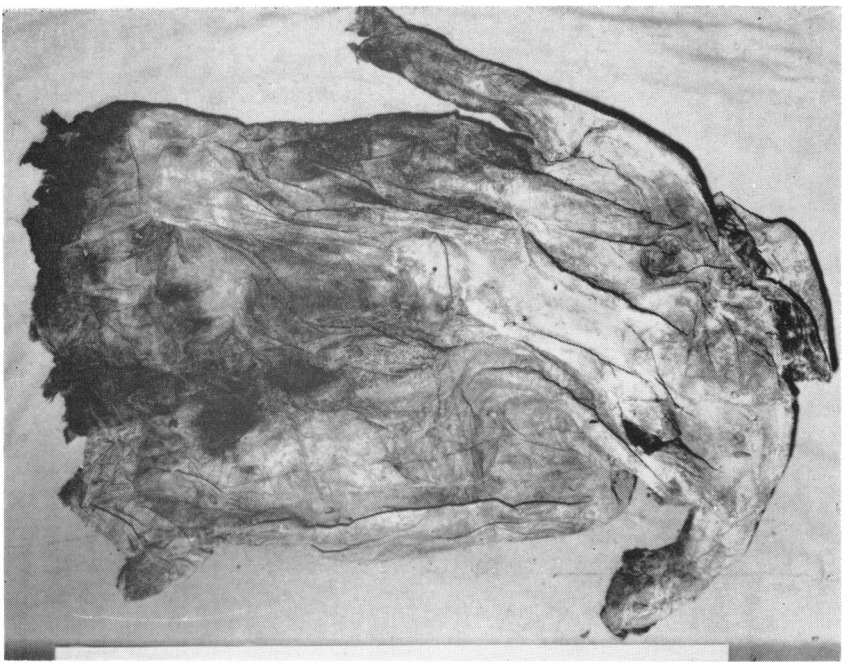


Fig. 2. Birdskin parka, with spotted fur collar.

wrapping of the mummy. The body was flexed at the hips and knees, with the arms extended down between the legs. Pathologic changes in the skeletal system were limited to minimal arthritic changes ("lipping") in the vertebral column. No fractures were seen. The brain presented as an occipital opacity. Radiographs of the maxilla revealed normal bony trabeculation. The antral floor was located 1 to 2 mm. above the apices of the teeth. The alveolar bone was flattened and cratered interproximally to the teeth; this gave evidence of periodontal disease. The periodontal membrane space and the lamina dura were markedly thickened; this together with marked dental attrition supported the probability of extreme dental occlusal stresses. The pulp chambers of the teeth did not exhibit calcific changes. There was no evidence of dental caries, and no impacted or supernumerary teeth were present. The viscera were poorly delineated. The outlines of the heart and lungs were faintly visible. The left side of the abdomen contained a number of faceted radio-opaque masses 3 to 5 cm. in diameter.

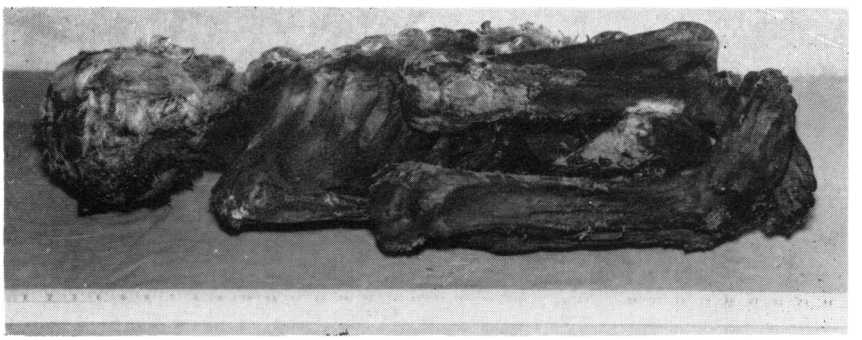


Fig. 3. Mummy, unwrapped, with birdskin cap covering right side of face and birdskin pouch between left leg and abdomen.

The wrappings were removed sequentially. The outer five were animal skins, probably seal or sea otter. The innermost layer was an eiderdown parka composed of numerous bird skins sewn together, with the feathers on the inside, and a yellow fur collar with black spots (Figure 2).

The body was that of an adult male of indeterminate age (Figure 3). The position was as indicated by the x rays. The cadaver weighed approximately 10 kg. It had a crown-rump length of 86 cm. and an approximate over-all length of 165 cm. The entire body was markedly mummified; the skin was dark brown and resembled leather.

A semicircular bird skin 22 cm. in diameter covered the right side of the face. There was moderate loss of facial features. The cephalic hair was short, black, and well preserved. There was mild frontal and parietal balding. Over large areas the hair appeared shortened and rounded at the tips, a change we have reproduced in normal hair by burning the tips. A grey-yellow moustache and full beard were present; these were brittle, like dry straw. The orbital contents were not preserved. The right ear was present and appeared relatively normal. The left ear was almost totally absent, but the auditory meatus was visible. There was no evidence to suggest whether the absence of the left ear had occurred before or after death.

Initial oral examination revealed the lips to be parted about 2 cm. The anterior teeth presented diastemata secondary to outward protrusion. It was necessary to remove a portion of the left cheek to reveal the oral cavity more clearly. The mandible was in a slightly open

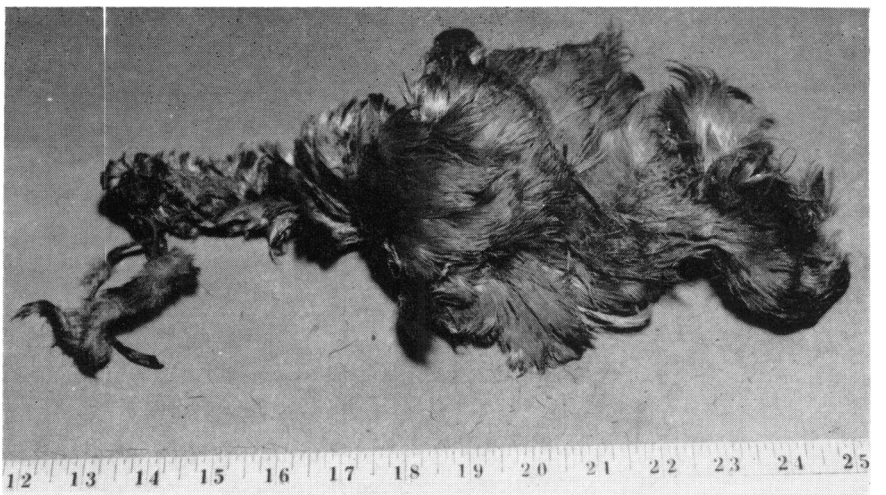


Fig. 4. Birdskin pouch, showing leather thongs at left end.

position; the tongue presented as a solid shrunken mass in the oropharynx. A full complement of teeth was present, the third molars having erupted in position within the dental arches. The occlusion of the teeth appeared normal (Class I).

The neck was markedly shrunken and revealed the outlines of the subjacent structures. The thyroid gland was not visible or palpable. The chest was symmetrical and devoid of hair. The abdomen was severely shrunken, and there was no evidence of a skin incision, abdominal or perineal. The external genitalia were poorly preserved; only a flattened but otherwise unremarkable penis was present. The extremities showed no abnormalities. No adipocere was seen. Lodged between the left forearm and the left side of the abdomen was another bird skin, which measured 30 by 10 cm. and had several short leather thongs at one end (Figure 4).

Initially we removed a 22 by 13 cm. flap from the anterior chest wall. Since the skin was extremely hard, the use of a Stryker autopsy saw was necessary. The ribs were unremarkable. The thoracic viscera were hard and shrunken but the five lobes of the lungs could be identified. A few diaphragmatic adhesions were noted. The diaphragm was intact and showed no other abnormalities.

The lungs were extremely brittle; after enlargement of the thoracic

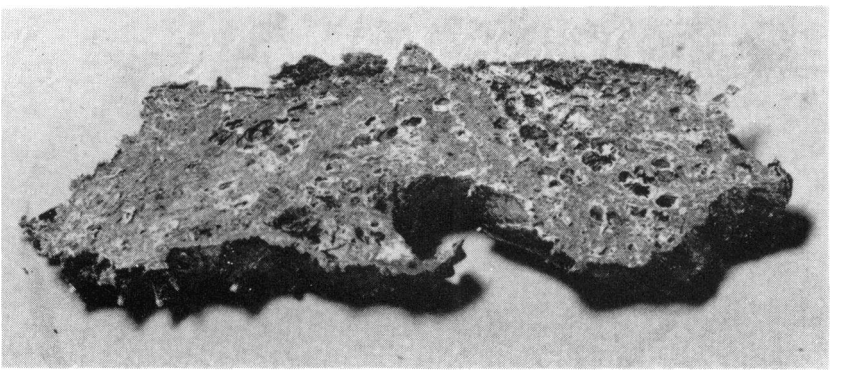


Fig. 5. Cut surface of left lung, showing preservation of architecture.

opening they were removed in several fragments roughly corresponding to the lobes. The cut surface of the lungs had a spongelike appearance suggestive of preserved pulmonary architecture (Figure 5) except for the right lower lobe, which was puttylike and homogeneous. The thoracic aorta, esophagus, and trachea were identified and removed *en bloc*.

The heart was markedly flattened, measuring 9 cm. in width, 8 cm. in height, and 1 to 2 cm. in thickness (Figure 6). It was fixed posteriorly and inferiorly to the adjacent tissue, and was recognizable as the heart by its position, general shape, and relation to the aorta. The chambers could not be identified. The organ was opened by several transverse incisions. The usual cardiac structure was completely obliterated and was replaced by multiple layers of unidentifiable tissue. Several superficial white dots 1 mm. large were seen on one of the inner layers.

In order to expose the abdomen the lower extremities were disarticulated at the hips and the left forearm at the elbow. The ventral abdominal wall was then removed. The abdominal viscera were poorly preserved; in fact, the stomach, small intestine, liver, spleen, pancreas, adrenals, urinary bladder, and prostate could not be recognized. The kidneys were represented by ill-defined retroperitoneal masses. Only the left half of the transverse colon and the descending colon were identifiable. They were filled with numerous dark brown, faceted hard fecal masses (Figure 7). These coprolites corresponded to the abdominal radio-opacities seen before the abdomen was opened; they

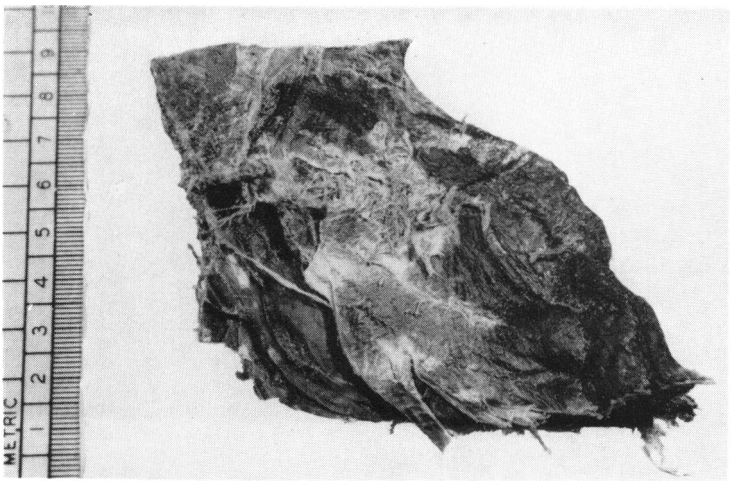


Fig. 6. Heart, showing preservation of general shape.

presented the same appearance when x-rayed after removal from the colon. They averaged 2.5 cm. in diameter, and presented a homogeneous dark brown appearance on section.

We removed the remaining abdominal tissues after making a circular incision around the inferior pelvic aperture. The rectum was slightly dilated; it measured 7 cm. in diameter and was filled with fecal material. The abdominal aorta and iliac vessels were well preserved and easily identified. A firm yellow plaque measuring 2 by 1 cm. was noted in the right iliac artery but there was no other gross evidence of atherosclerosis.

The skull was examined after removal of the calvarium. The bone and the dura were found to be intact. The latter was thin and transparent in the frontal area and thicker and opaque elsewhere. Upon removal of the dura the brain tissue was found to be shrunken into the posterior fossa of the cranial cavity, the major portion of which was empty (Figure 8). The brain was roughly rectangular; it measured 14 by 10 by 5 cm., and was covered with a fine crystalline material. No external features were identifiable, and the cut surface presented a homogeneous brown appearance throughout.

The upper left maxillary dentoalveolar process was removed *en bloc*. This segment extended anteroposteriorly from the alveolus of the upper left first bicuspid (tooth 12) to the left hamular notch,

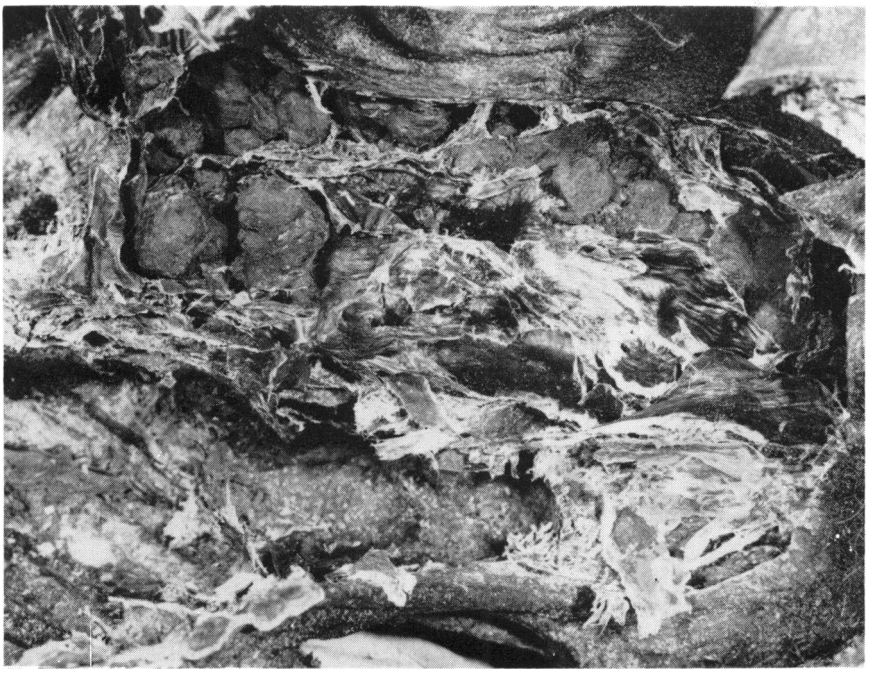


Fig. 7. Abdominal cavity (thorax to left), with coprolites outlining the splenic flexure and descending colon.

measuring 42 mm. in length. The mediolateral dimension included the left nasal floor, the maxillary antral floor, and the left malar process. The segment consisted of bone, teeth, and investing tissue. All teeth were present and were removed in situ with the specimen.

Extreme dental attrition was present to a point slightly beyond the interdental contacting tooth surfaces. Heavy dental calculus and periodontal bone loss were evident. The periodontoclasia was manifested by incipient bifurcation involvement of bone between the buccal roots of the upper first molar, and by a 4-mm. infraosseous periodontal pocket on the lingual aspect of the upper second bicuspid.

A posterior superior dental alveolar nerve was present at the tuberosity, and the palatine nerves were present in the pterygopalatine canal. The palatal mucosa was well defined, but the buccoalveolar mucosa was thin and friable. The Schneiderian membrane of the antral floor was exceptionally thin. No pathologic deficits or exostoses of the bony cortex were found.

Fig. 8. Position of brain in posterior midline, as seen after removal of the calvarium.

An additional wedge of tissue was obtained from the left half of the lip. The consistency was that of dry leather; a mucocutaneous junction was indiscernible.

The various tissues were sampled and rehydrated with a solution of 50 parts water, 30 parts absolute alcohol, and 20 parts 5% sodium carbonate solution. A third of the solution was removed and replaced by absolute alcohol for three successive days. The tissue was then embedded in paraffin and sectioned on an International Rotary Microtome. The staining techniques were those given in the *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*.[20]

The architecture of the heart was poorly preserved; the section was composed mostly of elongate bands of amorphous eosinophilic tissue in a framework of connective tissue. An endocardial surface was not

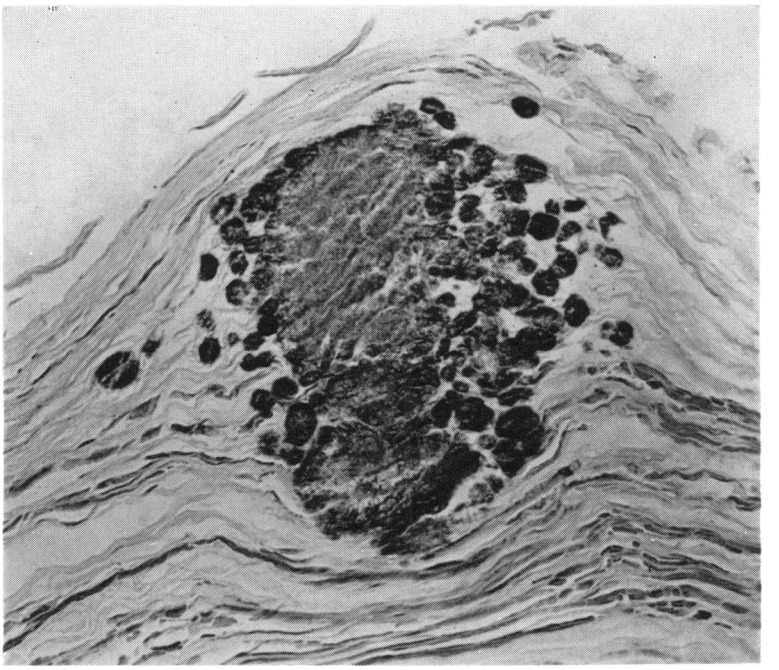


Fig. 9. Crystalline area in myocardium. Von Kossa stain. ×225.

discernible. Scattered throughout the tissue were small, roughly circular aggregates of pale eosinophilic crystalline material, which ranged from 50 to 200μ in diameter (Figure 9). The larger aggregates were seen in an area of homogeneous eosinophilic staining. These aggregates stained positively for calcium and with muci-carmine. The smaller areas stained more intensely than the larger. Examination with a polarizing microscope revealed the smaller areas to be birefringent. A Brown-Hopps stain revealed numerous bacteria in the crystalline areas, mostly gram-negative bacilli (Figure 10). Occasional gram-positive and gram-negative cocci were seen in these areas, in contrast to the many cocci which were scattered throughout the remainder of the heart (Figure 11). A Brown-Brenn stain failed to stain the bacilli, but did stain the cocci in the myocardium.

The pulmonary architecture was generally well preserved, although cellular detail was lost. A moderate amount of interstitial black anthracotic pigment was noted throughout. There was some coalescence of alveoli, interstitial fibrosis, and bronchial dilatation, and an over-all

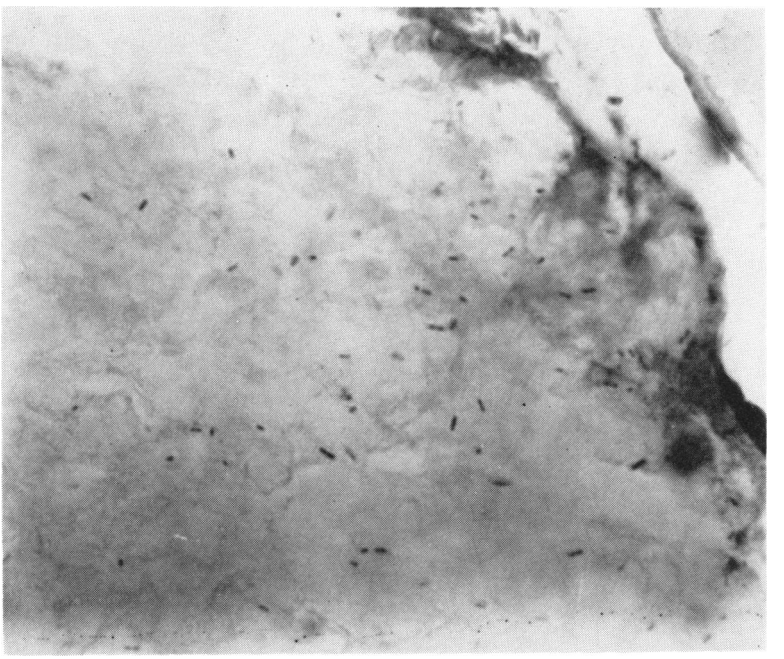


Fig. 10. Gram-negative bacilli in crystalline area of myocardium. Brown-Hopps stain. ×880.

increase in stainable elastic tissue was apparent. No particulate matter was seen in the alveoli. A number of crystalline aggregates, similar to those seen in the heart, were noted; many were pleural in location (Figure 12). Bacteria (gram-negative bacilli) were present, but were scanty as compared to the cardiac foci, except as noted below.

A section of the right lower lobe showed complete loss of the normal architecture. The tissue consisted of amorphous material which stained diffusely red with the Brown-Hopps stain. Many free gram-negative bacilli were present (Figure 13). Many small crystalline aggregates similar to those described above were scattered through the section.

Several sections of the trachea revealed preservation of the general architecture and the cartilage. Structures resembling chondrocytes were present in the lacunae. The mucosa and other cellular detail were absent. Several crystalline areas were seen in the cartilage, similar to those described above (Figure 14*A*). Step sections revealed these areas to be part of sinus tracts that communicated with the luminal surface, on which an outcropping of similar crystalline material was seen (Figures 14*B*, *C*). A bacterial stain revealed gram-negative bacilli.

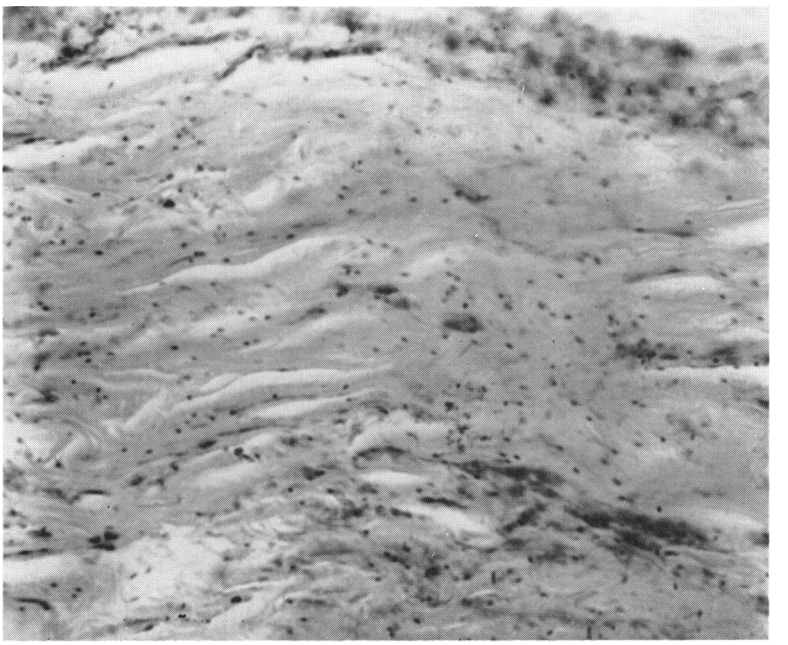


Fig. 11. Multiple gram-positive and gram-negative cocci in myocardium. Brown-Hopps stain. ×720.

Material from the right upper quadrant of the abdomen showed only connective tissue. No hepatic tissue was seen.

The colonic mucosa was not preserved. The muscularis and adventitia were poorly preserved and showed no abnormalities. The only recognizable structures were blood vessels. These contained granular material which took a pale eosinophilic stain. No vascular abnormalities were seen. Similar findings were noted in the rectum and anus.

Sections of the retroperitoneal area failed to reveal renal tissue but showed only connective tissue and a few blood vessels. Occasional crystalline foci were seen. Gram-negative bacilli were noted in these areas and in the immediately surrounding tissue.

Examination of the aorta revealed preservation of the three layers of the wall and of the elastic tissue. There was no calcification or atheromatosis but cellular detail was absent. There was excellent preservation of the general architecture of the iliac artery and vein, including the elastic tissue and a venous valve. The single atherosclerotic plaque noted on visual inspection was composed of cholesterol crystals and contained minute calcific foci (Figure 15).

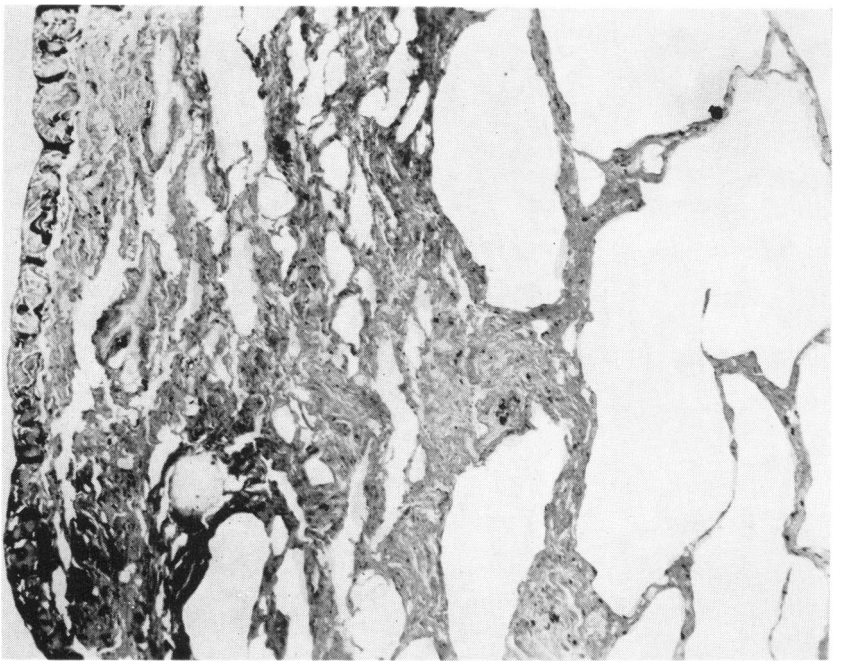


Fig. 12. Left lung, upper lobe, showing preservation of alveolar architecture, coalescence of alveoli, anthracotic pigment, and pleural crystalline area. H & E. ×72.

Several large open spaces were noted in the section of rectum. One of these contained calcific material at the periphery (Figure 16). The lining of the spaces was not preserved, but an elastic tissue stain revealed an arterial pattern; these spaces represent the hemorrhoidal artery. Other arteries examined showed no atherosclerosis, and were not otherwise remarkable.

The tissues of the neck ventral to the trachea showed only connective tissue. No thyroid tissue was seen.

Sections of skin from the abdominal wall, eyelid, ear, and lower lip showed only connective tissue, a few structures suggestive of blood vessels, hair follicles and shafts and, in the ear, well-preserved cartilage. The inferior labial artery was partially collapsed and exhibited a poorly stained plaque which was considered to be consistent with atherosclerotic intimal changes. A section from the right thigh showed connective tissue, skeletal muscle, and a few areas of pigmented epidermis. Multiple hair shafts were noted in each of several follicles (Figure 17).

Sections of femoral head and rib revealed good preservation of the

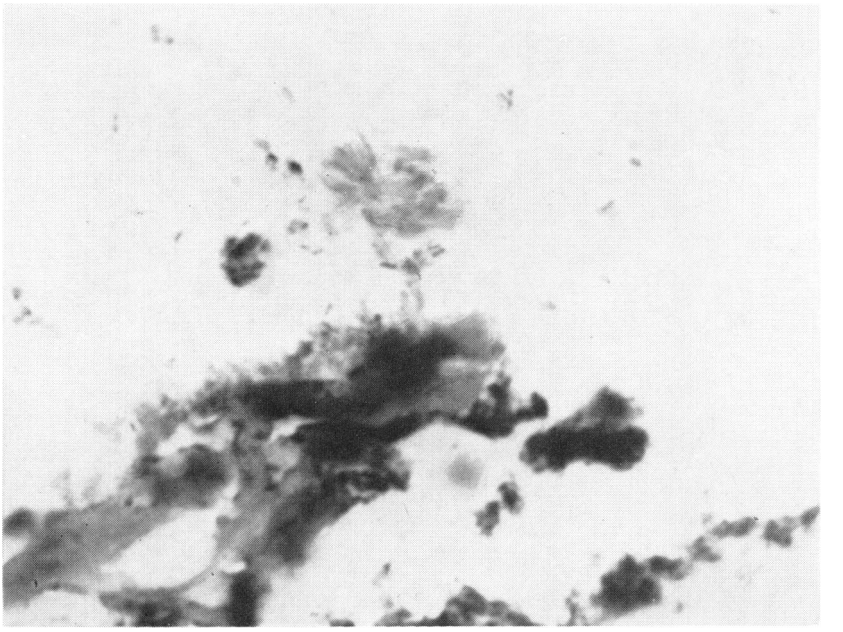


Fig. 13. Right lung. lower lobe, showing loss of normal architecture and presence of free gram-negative bacilli. Brown-Hopps stain. ×880.

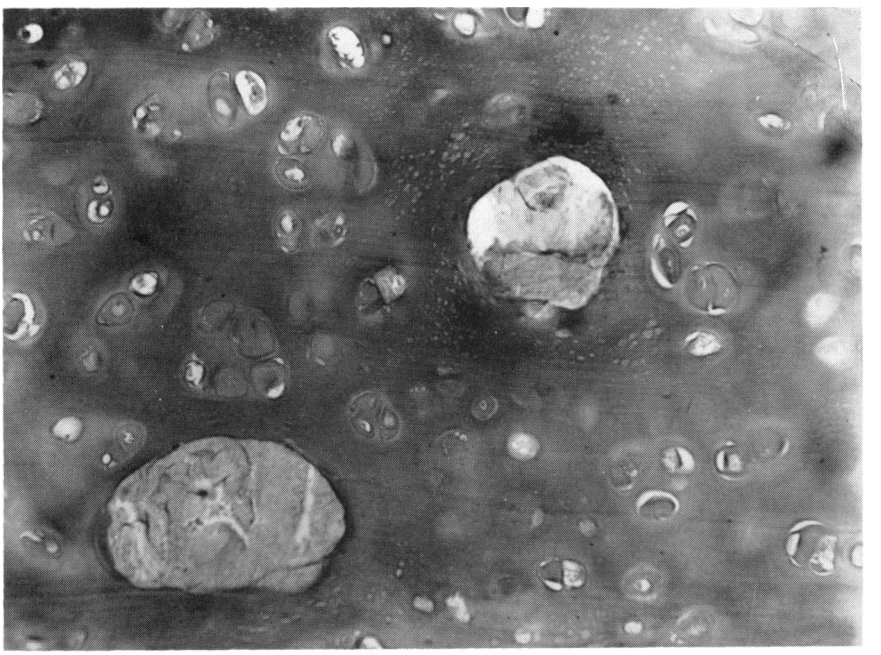
cortical and cancellous bone, which showed no abnormalities. The osteocytes and marrow were not seen.

The dura showed no cellular detail or abnormalities, and sections of the frontal and occipital areas of the brain showed only homogeneous eosinophilic acellular material.

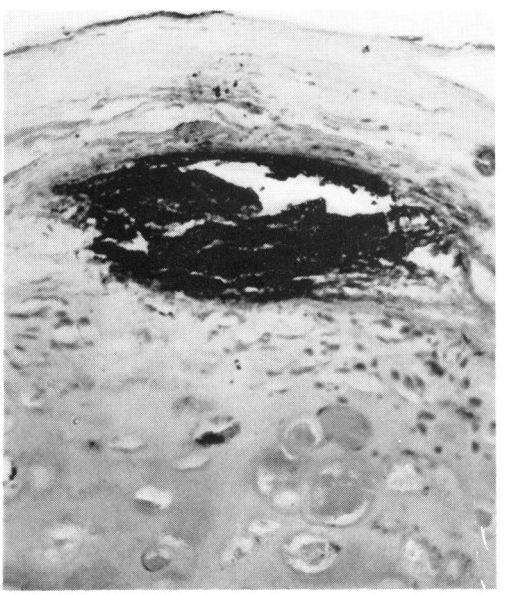
The osseous structures of the maxillae were well preserved. The cortical bone was prominently lamellated, and the Haversian systems were clearly defined. The lacunae were devoid of osteocytes.

The Schneiderian membrane of the antral floor consisted of connective tissue covered by a thin (12 μ) amorphous basophilic layer of epithelium. Polarized light elucidated the perivascular connective tissues and the perpendicular fibers (Sharpey's) of the periosteum.

The dental-pulp chambers were thoroughly desiccated and contained only scattered strands of unrecognizable filamentous elements. No odontoblasts were seen. Nonetheless, the hard tooth structures were in an excellent state of preservation. Ground-tooth sections revealed complete histologic properties of enamel and dentin. The Hunter-



A



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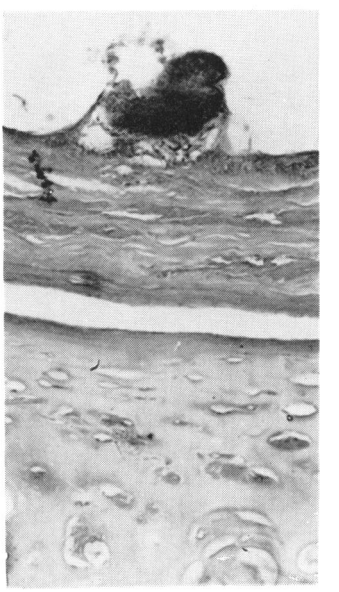

C

Fig. 14. Trachea, showing crystalline areas. ×200. *A*, within cartilage. H & E. *B*, in submucosa. Von Kossa stain. *C*, on luminal surface. Muci-carmine stain.

Fig. 15. Atherosclerotic plaque from iliac artery. H & E. ×84.

Schreger bands and the incremental lines of Retzius were clearly visualized in the enamel. The tubular nature of the dentin was perfectly preserved, and the incremental lines of Von Ebner and Owen were seen. Secondary dentin was present, measured about 350 μ in thickness, and was separated from the reparative (tertiary) dentin by a prominent basophilic line. The reparative dentin was 1 to 2 mm. in thickness under the worn cuspal areas where the attrition had abraded through the enamel into the dentin of the teeth. In spite of the severe attrition, structurally sound enamel remained in the intercuspal areas. Because of the excellent reparative response to attrition and the absence of

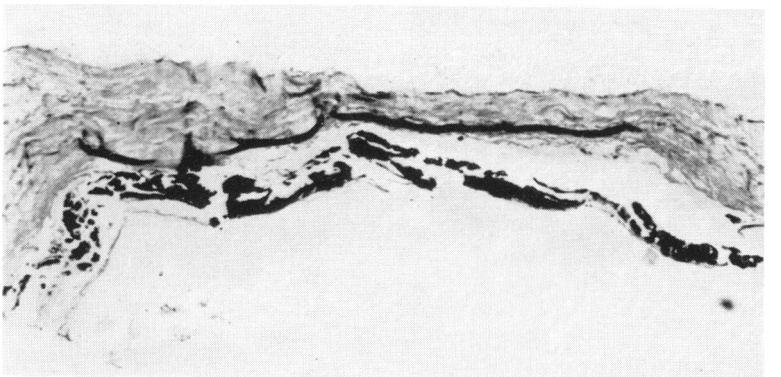

Fig. 16. Hemorrhoidal artery, showing atherosclerotic plaque on luminal surface and preservation of intramural elastic tissue. Elastic tissue stain. ×88.

periapical dental disease, it is reasonable to assume that the teeth were vital.

Dental calculus extended approximately 3 mm. above and below the dentoenamel junction on the surfaces of the teeth. The roots of the teeth exhibited considerable hypercementosis, which increased in thickness apically. Incremental lines were prominent, and scattered lacunae were present within the cellular cementum. The outer (acellular) cementum exhibited oblique bundling with incorporated fibers of the periodontal membrane. The maximum total thickness of the cementum was 1,000 μ. The acellular cementum measured about 150 μ. Areas of globular dentin (granular layer of Tomes) were prominent in the dentin next to the cementum.

A number of special studies were performed.

The blood group, determined on cancellous bone of the femoral head by a modification of the agglutination inhibition test described by Springer,[21] was O.

Cultures of the lung tissue failed to reveal viable organisms.

Analysis of skin, heart, kidney, brain, and muscle revealed almost total preservation of protein content. Enzyme analyses showed absence of activity of lactic dehydrogenase, creatine phosphokinase, glutamic-pyruvic transaminase, glutamic-oxalacetic transaminase, and alkaline dehydrogenase. The analyses were done on homogenates of dry tissue (20 mg./ml. of normal saline).

Neutron-activation analysis of lung, hair, fingernails, skin, and retroperitoneal tissue revealed no unexpected nuclides. The sodium activity

in all the samples was greater than anticipated from previous studies of dried human tissues,[22] and the right lower lobe showed some increase in ^{82}Br as compared to the remainder of the lung.

The crystalline areas were subjected to x-ray crystallographic analysis, which revealed them to be composed of acid ammonium sodium phosphate hydrate and apatite, a calcium-phosphate compound.

Examination of the coprolites was negative for parasites and the ova of parasites. Chemical analysis revealed the coprolites to be composed of ammonia and phosphates; as there was no calcium, their radioopacity was a function of density. The coprolites were soluble in a wide range of organic and inorganic solvents, including chloroform, acetone, ethanol, water and dilute acids, and alkalis.

Discussion

The burial customs of the Aleuts varied with the social status of the deceased.[23-25] We were fortunate in that the mummy selected for this study was apparently that of a common man, as the bodies of hunters and tribal leaders were eviscerated through an abdominal or perineal incision and the bodies were then stuffed with grass. Occasionally the eviscerated body was placed in a cold running stream for a period of time. Both eviscerated and noneviscerated bodies were then placed in a flexed position, wrapped in furs, and placed in a burial cave. The flexed position has been variously explained as an imitation of the fetal position, an attempt to economize on space, or an effort to prevent the dead from returning and harming the living. Jochelson[24] rejects these interpretations, and points out that the flexed position is the habitual leisure posture of the Aleuts. He considers the binding of the mummy bundle an effort to maintain the deceased in a comfortable position.

No grave goods were found other than the two bird skins already mentioned. The bird skin that covered the right side of the face is a cap, which had slipped over to one side of the face. The other, wedged between the left arm and the abdomen, probably was a pouch for carrying magical charms.[26] The eiderdown parka in which the body was wrapped may well have been reversed for burial, as these summer parkas are customarily worn with the feathers outside.

The autopsy was conducted by a relatively standard post-mortem technique, but the gross findings were limited, due to the desiccation

of the thoracic viscera and the deterioration of the abdominal contents and brain.

The most striking gross pathologic change found (beyond the general state of mummification) was the appearance of the lower lobe of the right lung, which was reduced to a soft, brown, semisolid state somewhat resembling consolidation. Histologic examination confirmed the destruction of the parenchyma in this area, and revealed the presence of free gram-negative bacilli and clumps of material which took a red color with the Brown-Hopps stain. Multiple small aggregates of crystalline material, often containing gram-negative bacilli, were found, not only in the right lower lobe, but in the other lobes of both lungs, the heart, trachea, and retroperitoneum.

There are a number of possible explanations for the appearance of the right lower lobe and the crystalline areas. A component of post-mortem change is indisputable; the question is one of degree. Do these areas represent ante-mortem disease or are they due entirely to post-mortem change?

The posterior midline position of the remains of the brain indicates that the body was in the supine position during the post-mortem period of liquefaction and subsequent desiccation. While the condition of the lower lobe of the right lung could be a manifestation of post-mortem autolysis, one would expect, given the supine position of the body, that a change of this nature would involve the posterior portions of both lungs. The mummification of the other lobes is evidence against autolysis. Conversely, the failure of one lobe to mummify implies a predisposing factor, such as ante-mortem disease.

Analysis of the crystalline material revealed it to be inorganic, and not to be confused with adipocere. No adipocere was seen grossly, although the foggy and hazy conditions common in the Aleutians are said to favor the formation of adipocere.[27] Adipocere results from the post-mortem autolysis of body fats, and consists primarily of palmitic, stearic, and hydroxystearic acids.[28] Evans[29] notes that the crystals of adipocere are found only in tissues containing fat and not in such structures as the lung and trachea. It is apparent that the crystalline material under discussion is not adipocere but probably represents post-mortem mineralization of areas containing discrete aggregates of gram-negative bacilli.

There are two possible explanations for the presence of the bacteria

in the crystalline foci. One is that the bacilli were present throughout the tissues and were preserved only in the areas of mineralization. Many gram-negative and gram-positive cocci are scattered throughout the tissues (Figure 11) and it is difficult to imagine a process which would preserve bacilli selectively in one area and cocci in another. The more plausible explanation is that the crystalline foci represent ante-mortem bacterial abscesses. The preservation of bacteria for 300 years is not unusual; bacteria have been stained in the intestinal contents of a 4,000-year-old Egyptian mummy.[6] The bacteria may have had a role in the process of mineralization by invoking a mechanism similar to that which results in adipocere.[27] Proteolytic bacterial enzymes may produce a localized acidic environment conducive to the deposition of calcium salts, especially if supersaturation resulted from desiccation. However, in the absence of experimental studies, a discussion of the process of mineralization remains speculative.

The distribution of the crystalline areas also suggests ante-mortem abscesses. As the bacteria in these foci appear to be the same as the gram-negative bacilli in the right lower lobe, one can infer that the terminal illness was lobar pneumonia (possibly caused by *Klebsiella pneumoniae*), with septicemia and multiple visceral abscesses. Attempts to identify the organisms immunologically were thwarted by the non-viability of the bacteria.

Post-mortem changes have altered the picture considerably. While they might have caused all the changes described, this appears to be improbable for the reasons already given. The lack of preservation of the abdominal viscera made it impossible to evaluate the role of intra-abdominal pathology in the death of the mummified subject.

The involvement of the tracheal cartilage can be explained by post-mortem loss of the resistance of the mucosa to infection. Bacteria present on the mucosal surface at the time of death may have invaded the mucosa and underlying cartilage, thereby producing the sinus tracts seen in Figure 14.

The pulmonary anthracosis can be attributed to the culinary habits of the Aleuts. Until recently they prepared their food over an open seal-oil fire, which filled their homes with smoke. Indeed, ocular changes in the Aleuts, noted by early visitors, were attributed to the smoke,[30] and modern visitors have found it impossible to live in Aleut houses for the same reason.[31] The lungs showed changes consistent with

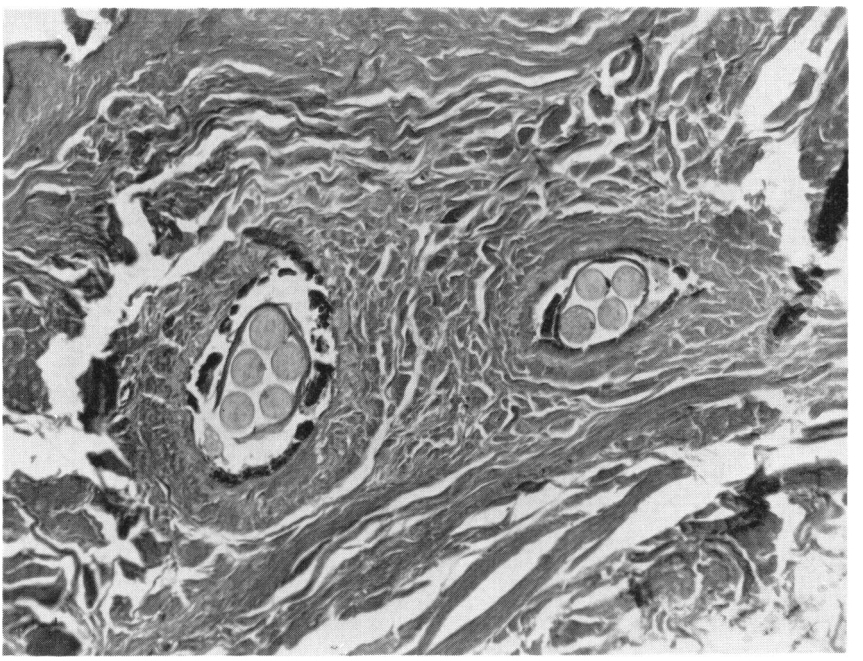

Fig. 17. Skin from right thigh, with multiple hair shafts in each of two follicles. H & E. ×225.

moderate emphysema and bronchiectasis, probably of the same origin. Tobacco may be ruled out as a cause, since the use of tobacco was unknown before the advent of the Russians.

Severe masticatory dental stresses must have existed, because of the marked dental attrition, the increased thickness of the lamina dura, the prominent hypercementosis of the tooth roots, and the significant deposits of tertiary dentin.

The presence of periodontal disease was manifested by deposits of heavy dental calculus, periodontoclastic bone changes, and migratory protrusion of the anterior teeth.

There was no evidence of impacted teeth, supernumerary teeth, missing teeth, dental caries, or malocclusion disorders. Similarly, the maxillary bone and antrum exhibited no pathologic changes. A possible atheromatous plaque was noted in the inferior labial artery.

Sections of the major blood vessels showed only mild focal atherosclerosis of the iliac vessels. This finding, combined with the roentgen evidence of mild arthritic changes, enabled us to estimate the age of the subject at the fourth or fifth decade.

There were two interesting incidental findings. Chondrocytes appeared to be well preserved, but this is probably an artefact of condensation of cellular material in the lacunae.[32] An inexplicable finding was the presence of several hair shafts in single follicles in a section of skin (Figure 17). As the cadaver was separated from the fur wrappings by an eiderdown parka, this section could not be one of adherent animal skin.

The negative findings are also noteworthy. There was no evidence of trauma, and no foreign material or organisms were seen in the pulmonary alveoli; this evidence ruled out accidental death by drowning. No poisons were found in the tissues analyzed by neutron activation. Stains for fungi and tubercle bacilli were negative.

The blood group, determined on bone from the femoral head, was type O. The science of paleoserology is still in a state of evolution[33] but blood groups have been successfully determined in varied mummified material.[1,34-36] Candela[36] typed 30 of the Aleutian mummies when they arrived in Washington, D.C., by use of vertebral bone corings. The blood-group distribution was: eleven O, eleven A, six B, and two AB. These results are in contrast to the prevalence of type O in Eskimos and American Indians (although some type A is found among Northwest Coast Indians). Candela noted that the Aleuts have an almost identical blood type distribution to that of Eastern Siberian tribes, but he felt that the number of individuals typed was too small to draw any valid conclusions regarding the origin of the Aleuts.

No parasites or parasitic ova were seen in the coprolites. The ova of *Trichuris trichiura* have been found in the rectal contents of a frozen Inca child, dated archeologically at 450 years,[37] and the ova of *Schistosoma haematobium* have been demonstrated in the tissues of Egyptian mummies more than 3,000 years old.[6]

The results of other special studies performed, such as chemical analysis of the coprolites and protein and enzyme analysis of the various tissues are given, but the absence of previous studies of this nature makes interpretation of the data difficult. Worthy of note, however, is the preservation of protein and the loss of enzymatic activity.

Summary

The examination of a 200- to 300-year-old Alaskan cadaver mummified by desiccation is presented. Histological studies were performed

after rehydration of the tissues. The gross findings and examination of the sections suggested that the cause of death was lobar pneumonia caused by a gram-negative bacillus, possibly complicated by septicemia and diffuse metastatic abscesses. The abdominal viscera were not preserved, and the role of intra-abdominal disease in the death of the subject could not be assessed. Other findings included pulmonary anthracosis and mild atherosclerosis. Severe masticatory dental stresses were attested to by marked dental attrition, increased thickness of the lamina dura, prominent hypercementosis of the dental roots, and significant deposits of tertiary dentin. Periodontal disease was manifested by deposits of heavy dental calculus, periodontoclastic bone changes, and migratory protrusion of the anterior teeth. No adipocere was seen and there was no evidence of death from trauma, drowning, or poisoning.

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All illustrations used in this paper are U.S. Army photographs.

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